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Psychosocial predictors of low birthweight: a prospective study

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Objective To examine the role of psychosocial risk factors for low birthweight.

Design A prospective study.

Setting Obstetric outpatient clinics of the University Hospital Vrije Universiteit, Amsterdam.

Participants Three hundred and ninety-six nulliparous women.

Methods Questionnaires on background variables, daily stressors, psychological and mental wellbeing, social support and work factors were completed by the women in the first, second and third trimester of pregnancy. Low birthweight for gestational age was defined at different cut off points: 1. ≤ 10th customised birthweight centile ($n = 69$); 2. ≤ 5th customised birthweight centile ($n = 54$); 3. < 3rd customised birthweight centile ($n = 35$); and 4. ≤ the 10th Dutch birthweight centile ($n = 40$). Multivariate logistic regression was applied and the results were expressed in odds ratios and their 95% confidence intervals.

Results When the cut off level was defined ≤ 5th and < 3rd customised centile, the number of daily stressors in the first trimester was a statistically significant risk factor (OR 1·04, 95% CI 1·01–1·07 and OR 1·04, 95% CI 1·01–1·08). No significant psychosocial risk factors could be identified when low birthweight for gestational age was defined ≤ the 10th customised birthweight centile. When low birthweight for gestational age was defined ≤ the 10th Dutch birthweight centile, number of hours housekeeping per week in the first trimester (OR 1·59, 95% CI 1·03–2·46), low subjective severity rating of daily stressors in the first trimester (OR 0·41, 95% CI 0·17–0·97) and depressive mood in the first trimester (OR 1·12, 95% CI 1·01–1·24) were statistically significant psychosocial risk factors after controlling for maternal weight and height, number of cigarettes smoked per day and educational level.

Conclusions In the first trimester of pregnancy maternal psychosocial factors are associated with an increased risk of low birthweight. The specific psychosocial risk factors found were different when the definition of low birthweight was changed. Therefore, in this field of research, we suggest use of the most valid outcome measure for low birthweight, being the customised birthweight centiles.

INTRODUCTION

Birthweight, gestational age at birth, and neurological condition of the infant in the neonatal period and later life are generally accepted measures to assess perinatal outcome. Low socioeconomic status[1], cigarette smoking[1–5], low income, unemployment[6], low family functioning[1], exposure to life events[7], household strain[8] and high work load[9] have been associated with increased risk for low birthweight for gestational age. Studies of psychosocial factors and birthweight show inconsistent results[10]. Most studies lack a prospective design with due attention to chronic stressors and adequate attention to biomedical risk factors and well known moderating factors such as social support[10]. In one prospective study risk for low birthweight was found to be increased by exposure to life events during pregnancy[11].

Birthweight is influenced by physiological and pathological factors. In order to diagnose fetal growth retardation carefully, it is important to determine deviation from the ideal birthweight based on biomedical measures[12–16]. The commonly used Dutch centiles of birthweight are adjusted for parity, neonatal gender, and gestational age[17]. The clinical applicability of the Dutch centiles has

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frequently been questioned. In the preterm infants a high percentage of morbidity was present resulting in skewed centiles. Furthermore, present data of 80,000 pregnancies were obtained between 1931 and 1967.

Gardosi *et al.*[12] analysed biomedical characteristics of almost 40,000 pregnancies with a physiological course. Birthweight centiles were adjusted for maternal height, booking weight and maternal ethnic origin in addition to the commonly used variables as parity, gestational age and neonatal gender. In a recent study by de Jong *et al.*[16] the adjusted, or customised birthweight centiles appeared to be very well applicable in The Netherlands.

We have set up a prospective study in a group of nulliparous women, to examine the role of several risk factors for low birthweight at each gestational age, with the aim of studying the relationship between antepartum psychosocial factors and low birthweight. Birthweight is expressed in customised birthweight centiles and in Dutch birthweight centiles to examine whether the results depend on the applied standard. The current study is the first to explore psychosocial factors and birthweight using a customised birthweight measure. We used different cut off levels for birthweight centiles to examine the associations with psychosocial factors. Stressors were defined as daily stressors, because they have been demonstrated to be better predictors of subjective and objective health complaints than the more dramatic, but less frequent, life events[18,19].

METHODS

Given an incidence of 10% of infants with low birthweight for gestational age, the necessary sample size was calculated with an α of 0·5 and a power of 0·80[20]. A sample of 400 women was chosen, taking into account 5% loss during follow up. Between January 1992 and January 1994, 560 consecutive pregnant, nulliparous women in the obstetric outpatient clinics of the University Hospital Vrije Universiteit Amsterdam were asked to participate. The University Hospital is situated in an area of Amsterdam with a predominantly upper middle class population. Of these women, 442 (79%) agreed to participate in the study. Written informed consent was obtained and the protocol was approved by the institutional review board for clinical investigation at this facility. Inclusion criteria were: nulliparity, age over 17 years, no present psychological or psychiatric disease necessitating hospitalisation, and, in order to obtain a reliable completion of the questionnaires, the ability to read and write Dutch. Participants were recruited at the first antenatal visit by the first author (K.M.P.) or trained medical students who explained the details of the study at intake. The average gestational age at entry was $13^{\pm 2}$ weeks.

Three hundred and ninety-six participants were eligible for this study. Forty-six women (10·4%) were lost during follow up because of miscarriage before 16 weeks amenorrhea (n = 7), withdrawal after initial participation (n = 13), moving to another area (n = 4), maternal disease such as severe maternal Crohn disease, sickle cell anemia, and uterine anomaly possibly influencing pregnancy outcome (n = 13), delivery of an infant with severe congenital abnormality (n = 7), and twin pregnancy (n = 2). The most important maternal characteristics are presented in Table 1.

Measures

Birthweight and gestational age at delivery were obtained from medical charts. For the purpose of the analysis, two methods of calculating birthweight for gestational age centiles were used.

1. Customised birthweight centiles calculated with a computer program which adjusts for parity and infant gender, as well as maternal height, weight and ethnic group. This program contains coefficients for these physiological variables based on 40,000 ultrasound dated pregnancies in Nottingham. The program adjusts or customises the weight for gestational age standard for each individual pregnancy and has been described earlier[12,15]. It reveals a continuous measure with a 0–100 range. The average weight of the Dutch and Nottingham populations is very similar[16]. This justifies the use of the available program for this analysis.
2. The Dutch birthweight for gestational age charts are based on 80,000 pregnancies with reported certain menstrual dates delivered in Amsterdam between 1931 and 1967[17]. This Dutch population standard is currently used in The Netherlands in all hospitals and includes separate tables for parity and the infant's gender. Since all women were nulliparous, it was not needed to control for parity. These centiles are expressed in categories: < 2·3; 2·3–5; 5–10, 10–25, 25–50, 50–75, 75–95, 95–97·7, > 97·7.

Infants with birthweights ≤ 10th centile according to the customised birthweight centiles and the Dutch centiles were considered to have low birthweight for gestational age.

Gestational age was expressed in days of amenorrhea. All women had a dating scan before 16 weeks of gestation, either by crown–rump length in the first trimester or biparietal diameter in the second trimester. In accordance with the clinical protocol at the time of the study gestational age was ascertained by menstrual dates, or by scan if the discrepancy between menstrual dates and scan dates exceeded seven days.

Daily stressors were measured by the Everyday Problems Checklist (EPCL)[21]. Since it has been suggested that too much attention has been paid to life

events, neglecting the importance of other sources of stress (e.g. chronic stressors, daily stressors, or role-stressors)[22], the EPCL was developed to study chronic stressor exposure. The EPCL is a self-report questionnaire containing 114 items tapping several domains of daily life including family matters, living and working conditions, physical appearance, transactions, and business. A few examples of statements are: (a) you have had a disagreement with your neighbours; (b) you were not satisfied with your personal appearance; or (c) you have had a conflict with your colleagues. Respondents have to check the items describing situations that have occurred in their personal life in the last two months and to rate the subjective severity of the identified stressors. Since all participants were nulliparous, five items referring to other children had been omitted. The scores for the number of items checked (possible score range 0–109) and an average subjective severity rating (possible score range 0–3) were calculated. The EPCL has been applied in a number of psychological[5] and psychobiological[22,23] studies. Test–retest reliability with a one week interval was 0·87 for the frequency rating, and 0·76 for the subjective severity rating[21], which can be considered as adequate.

Social support was measured utilising a questionnaire developed by Van Sonderen[24]. It contains two scales measuring social interactions (i.e. actual received support; possible score range 0–150) and satisfaction (i.e. discrepancies between desired and received support; possible score range 0–86). Cronbach's alpha indicates adequate reliability.

Workload was assessed by a self-constructed measure, developed on the basis of the questionnaire of the Continuous Social Environment Study by Statistics Netherlands[25]. Items focus on amount of hours spent with housekeeping activities, educational level, specific courses, type of profession, number of working hours, and degree of subjective physical strain.

Psychological and somatic wellbeing was determined using the Dutch version of the Hopkins Symptom Checklist[26]. As recommended by Kleiverda *et al.*[27], 23 of the 57 original items were deleted because of possible confounding with typical pregnancy symptoms (e.g. faintness, dizziness, and decreased sexual interest) resulting in a depressive mood such as difficulties making decisions, feeling inferior to others, and being unable to get rid of bad thoughts or ideas; somatic complaints such as feeling low in energy, weakness in parts of the body, and headaches; and anxiety dimension such as trembling and heart pounding or racing. The possible score ranges were 0–39, 0–18 and 0–12, respectively. It has to be noted that in a normal population, such as the women in this study, scores of these dimensions are rather low as compared with, for instance, a psychiatric population.

Table 1. Maternal characteristics (n = 396) and psychosocial variables. Values are given as mean (SD) or n [%].

Maternal characteristics	
Age (years)	30·7 (4·6)
Height (cm)	169·4 (6·5)
Weight (kg)	63·5 (10·2)
Educational level	
Low	47 [12]
Middle	166 [42]
High	179 [45]
Unknown	4 [1]
Ethnic group	
European	370 [93·4]
Afro-Caribbean	13 [3·3]
Indian subcontinent	7 [1·8]
Other	6 [1·5]
Proposed risk factors (range)	
No. cigarettes per day*	
1st trimester	1·7 (4·4)
2nd trimester	1·6 (4·0)
3rd trimester	1·6 (4·1)
No. hours housekeeping per week (4 categories; 10 h per category)*	
1st trimester	1·8 (0·9)
2nd trimester	1·9 (0·8)
3rd trimester	2·0 (0·9)
No. daily stressors (0–109)*	
1st trimester	22·9 (13·0)
2nd trimester	21·5 (12·7)
3rd trimester	19·6 (12·5)
Severity rating daily stressors (0–3)*	
1st trimester	1·4 (0·5)
2nd trimester	1·3 (0·5)
3rd trimester	1·3 (0·5)
Social interactions (0–150)*	
1st trimester	78·0 (13·4)
2nd trimester	76·6 (14;2)
3rd trimester	77·1 (14·6)
Satisfaction with received support (0–86)*	
1st trimester	93·4 (9·4)
2nd trimester	94·4 (9·4)
3rd trimester	94·8 (8·8)
Depressive mood (0–39)*	
1st trimester	5·1 (5·1)
2nd trimester	4·7 (4·6)
3rd trimester	5·1 (7·0)
Anxiety (0–12)*	
1st trimester	1·3 (1·6)
2nd trimester	1·3 (1·6)
3rd trimester	1·3 (2·1)
Somatic complaints (0–18)*	
1st trimester	4·7 (3·0)
2nd trimester	3·9 (3·0)
3rd trimester	3·6 (3·7)

*In previous 2 months.

Procedure

The first booklet of questionnaires, which also served other research purposes[28], was handed out for completion at home. The second and third questionnaires were sent by mail and were completed between 24 and 26

weeks and between 34 and 36 weeks. Participants received one or more reminders when they had neglected to complete (part of) the questionnaire. Response rates of the questionnaires were 99·7% in the first trimester of pregnancy (395 of 396 questionnaires were returned); 99·7% in the second trimester (394 of 395); and 98·7% in the third trimester (381 of 386). Ten women gave birth before the third measurement.

Data analysis

Statistics were calculated with SPSS for Windows (Version 7·5·2, SPSS Inc, Chicago, Illinois, USA). Results were expressed as mean and standard deviation. Student's *t* tests were used when appropriate. In order to obtain an overall picture, multivariate logistic regression analysis was performed to determine the predictive value of the psychosocial variables with regard to low birthweight for gestational age. This was done for each trimester separately because the subsequent measurements have a high intercorrelation which could disturb an adequate picture. In this way the predictive power of the proposed risk factors in the different trimesters with respect to low birthweight for gestational age could be examined. Results were expressed in odds ratios and their 95% confidence intervals.

For the continuous proposed risk factors, it holds that the odds ratios given, are odds ratios per point. For instance, an odds ratio of 1·10 for number of daily smoked cigarettes means that for each cigarette, the odds ratio increases by 0·10, given that all other factors remain constant. Twenty cigarettes per day then yields an odds ratio of 3·00. These analyses have been carried out for the customised birthweight centiles and for the Dutch centiles.

The following continuous proposed risk factors were included in the analyses: maternal weight, maternal height, number of daily smoked cigarettes, daily stressors (number of daily stressors and their subjective severity rating), social support (total number of social interactions, and total satisfaction with received support) and mental and physical wellbeing (depressive mood, anxiety, and somatic complaints). The interval variables were: educational level (high, middle or low) and number of hours housekeeping per week: 1. < 10 h per week; 2. 10–20 h per week; 3. 20–30 h per week; 4. > 30 h per week). Paid work was assessed as a dichotomous variable (yes/no).

RESULTS

Table 1 shows the maternal characteristics and the psychosocial variables, expressed as mean (standard deviation) for each trimester of pregnancy. Average age was 30·7 (4·6 SD) years. The mean age of women with initial infertility (n = 58; 15%) who became pregnant after infertility treatment (e.g. hormonal induction or *in vitro* fertilisation) did not differ from the rest of the group (31·3 (4·1) years *versus* 30·6 (4·6) years; P = 0·3). The majority of the participants (93·4%) were of European origin.

Using the customised birthweight centiles, the infants of 69 had a birthweight centile of ≤ 10. The mean birthweight in this group was 2571 g (658)[12]. Application of the Dutch centiles revealed 40 participants whose infants had a birthweight ≤ 10th centile; the mean birthweight in this group was 2427 g (636). Applying the customised birthweight centiles, two participants of those classified ≤ 10th centile according to the Dutch centiles were now classified > 10th centile. Thirty-one participants, whose infants had mean birthweight 2768 g (624) and who were classified > 10th centile according to the Dutch centiles, were now classified ≤ 10th centile. The customised centiles revealed a larger group of infants with birthweights ≤ 10th centile, with a higher mean birthweight than the group ≤ 10th centile according to the Dutch centiles. Therefore, the cut off level of the customised centiles were also chosen at the 5th and the 3rd centile, revealing groups of, respectively, 54 and 35 participants (mean birthweights of 2480 g (705) and 2247 g (766), respectively). Twenty participants in the group ≤ 5th customised birthweight centile whose infants had mean birthweight 2649 g (742) were classified > 10th centile in the Dutch centiles. Eight participants in the group < 3rd customised birthweight centile whose infants had mean birthweight 2218 g (947) were classified > 10th centile in the Dutch centiles. In comparison the group ≤ 5th Dutch centile consisted of 18 women whose infants had a mean birthweight of 2129 g (689). The group < 2·3 Dutch centile consisted of eight women whose infants had a mean birthweight of 1926 g (871).

The Pearson correlation between the centiles obtained with the customised birthweight centiles and the upper limit of the Dutch birthweight centiles was 0·88 (P < 0·01). The distribution of the Dutch centiles was skewed to the right, and the distribution of the customised birthweight centiles was skewed to the left (Fig. 1).

The association between psychosocial factors and low birthweight for gestational age was demonstrated using multivariate logistic regression analysis. Four different cut off points for low birthweight for gestational age were used: 1. ≤ 10th customised birthweight centile (n = 69); 2. ≤ 5th customised birthweight centile (n = 54); 3. < 3rd customised birthweight centile (n = 35); and 4. ≤ 10th Dutch centile (n = 40).

When low birthweight for gestational age was defined by a customised birthweight centile at or below the 10th centile, psychosocial factors did not prove to be a risk factor for low birthweight for gestational age in

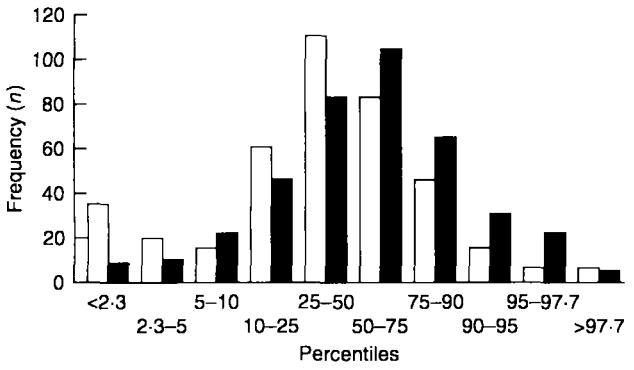

Fig. 1. Bar chart of the distribution of the customised birthweight centiles (□) and the Dutch birthweight centiles (■) in the study population ($n = 396$). The customised centiles are expressed in the same categories as the Dutch centiles to compare both figures.

addition to the biomedical risk factors: cigarette smoking and educational level (Table 2). The range of the proposed risk factors is shown in Table 1.

An additional analysis was carried out with the low birthweight for gestational age criterium set ≤ 5th centile (Table 3). Number of cigarettes per day was a statistically significant risk factor in each trimester. Educational level was a risk factor in this analysis, and number of daily stressors in the first trimester was an additional risk factor (OR 1·04, 95% CI 1·01–1·07). The latter means that, for each stressor, the odds ratio was increased with 0·04 (e.g. when a person reported 40 stressors, the odds ratio was 2·60 to obtain an infant with a birthweight ≤ 5th centile). Table 4 shows that when the low birthweight for gestational age criterium was set at < 3rd customised birthweight centile the results were comparable to those shown in Table 3. However, in the third trimester, educational level appeared to be the most important risk factor of the risk factors studied, whereas cigarette smoking was not a statistically significant factor in this analysis.

When the Dutch birthweight centiles were used to define low birthweight for gestational age, setting the low birthweight for gestational age criterium ≤ 10th centile, different results were obtained (Table 5). Because the Dutch birthweight centiles do not control for maternal height and weight, these variables were added in the logistic regression analysis. In this analysis smoking was a statistically significant risk factor in the first and second trimester of pregnancy. Maternal height and weight were apparently determining risk factors, with odds ratios below 1·00. In addition, the number of hours housekeeping per week in the first trimester (OR 1·59), low subjective severity rating of daily stressors in the first trimester of pregnancy (OR 0·41), and depressive mood in the first trimester (OR 1·12) were risk factors of low birthweight for gestational age in this analysis.

DISCUSSION

The current study suggests that psychosocial factors in pregnancy contribute to low birthweight for gestational age, independently of number of cigarettes smoked per day, educational level, and maternal height and weight. The interest lies predominantly in the finding that only

Table 2. Odds ratios (OR), 95% confidence intervals (CI) and *P* values of proposed risk factors to low birthweight for gestational age; low birthweight criterium set ≤ 10th centile ($n = 69$), applying customised birthweight centiles[12].

	1st trimester		2nd trimester		3rd trimester	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)	1·04 (0·98–1·11)	0·2	1·03 (0·97–1·09)	0·4	1·03 (0·97–1·11)	0·3
No. cigarettes per day*	1·07 (1·01–1·13)	0·01	1·10 (1·03–1·17)	< 0·01	1·08 (1·01–1·15)	< 0·05
Educational level (high–low)	1·54 (1·00–2·38)	0·06	1·52 (0·96–2·38)	0·08	2·00 (1·23–3·33)	< 0·01
Paid work (yes/no)	1·35 (0·61–2·98)	0·5	1·17 (0·56–2·46)	0·7	1·39 (0·63–3·09)	0·4
No. hours housekeeping per week*	1·31 (0·93–1·84)	0·1	0·99 (0·69–1·41)	1·0	0·82 (0·57–1·17)	0·3
No. daily stressors*	1·02 (0·99–1·05)	0·1	0·99 (0·96–1·02)	0·6	1·01 (0·98–1·04)	0·7
Severity rating daily stressors* (low–high)	0·69 (0·36–1·33)	0·3	0·73 (0·39–1·38)	0·3	0·83 (0·42–1·66)	0·6
Social interactions*	1·00 (0·97–1·02)	0·8	1·00 (0·98–1·02)	0·7	1·01 (0·99–1·04)	0·2
Satisfaction with received support*	1·00 (0·96–1·04)	1·0	0·99 (0·95–1·02)	0·5	1·00 (0·96–1·04)	0·9
Depressive mood*	1·05 (0·97–1·13)	0·2	1·01 (0·93–1·10)	0·8	1·03 (0·95–1·13)	0·5
Anxiety*	0·89 (0·72–1·11)	0·3	0·91 (0·72–1·14)	0·4	0·84 (0·65–1·09)	0·2
Somatic complaints*	0·99 (0·88–1·10)	0·8	1·07 (0·96–1·20)	0·2	1·10 (0·99–1·24)	0·08

* In previous 2 months.

Table 3. Odds ratios (OR), 95% confidence intervals (CI) and *P* values of proposed risk factors to low birthweight for gestational age; low birthweight criterium set ≤ 5th centile ($n = 54$), applying customised birthweight centiles[12].

	1st trimester		2nd trimester		3rd trimester	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)	1·04 (0·97–1·12)	0·2	1·03 (0·96–1·10)	0·4	1·03 (0·96–1·11)	0·4
No. cigarettes per day*	1·10 (1·03–1·16)	< 0·01	1·12 (1·05–1·19)	< 0·01	1·09 (1·02–1·16)	< 0·05
Educational level (high–low)	1·23 (0·74–2·02)	0·4	1·10 (0·67–1·80)	0·7	1·52 (0·89–2·60)	0·1
Paid work (yes/no)	1·28 (0·53–3·11)	0·6	1·10 (0·49–2·45)	0·8	1·25 (0·52–2·99)	0·6
No. hours housekeeping per week*	1·36 (0·93–1·98)	0·1	1·09 (0·75–1·59)	0·6	0·89 (0·59–1·32)	0·6
No. daily stressors*	1·04 (1·01–1·07)	< 0·01	1·00 (0·97–1·03)	0·9	1·02 (0·99–1·05)	0·3
Severity rating daily stressors* (low–high)	0·70 (0·34–1·45)	0·3	0·94 (0·47–1·87)	0·9	0·99 (0·46–2·15)	1·0
Social interactions*	0·99 (0·97–1·02)	0·4	0·99 (0·97–1·02)	0·6	1·00 (0·98–1·03)	0·9
Satisfaction with received support*	1·02 (0·98–1·06)	0·4	1·01 (0·96–1·05)	0·8	1·03 (0·98–1·09)	0·3
Depressive mood*	1·05 (0·96–1·15)	0·3	0·98 (0·89–1·08)	0·7	1·04 (0·95–1·14)	0·4
Anxiety*	0·85 (0·66–1·10)	0·2	1·05 (0·83–1·33)	0·7	0·95 (0·73–1·25)	0·7
Somatic complaints*	0·94 (0·83–1·07)	0·4	1·03 (0·91–1·16)	0·7	1·03 (0·91–1·17)	0·6

*In previous 2 months.

first trimester psychosocial factors exert a negative effect on low birthweight. When low birthweight is defined ≤ 5th or < 3rd customised centile, daily stressors in the first trimester appear to be a psychosocial risk factor with an odds ratio of 0·04 per stressor (OR 1·04). When low birthweight is defined ≤ 10th Dutch birthweight centile, other psychosocial risk factors in the first trimester are identified: number of hours housekeeping per week (OR 1·59; i.e. increasing the risk of low birthweight for gestational age with 0·59 per 10 hours housekeeping per week), low subjective severity rating of daily stressors (OR 0·41), and depressive mood (OR 1·12).

Compared with the commonly used Dutch birthweight centiles, customised birthweight centiles categorise more infants as low birthweight for gestational age, irrespective of which cut off level was applied. There is, however, a great overlap between the 5th and 3rd cus-

Table 4. Odds ratios (OR), 95% confidence intervals (CI) and *P* values of proposed risk factors to low birthweight for gestational age; low birthweight criterium set < 3rd centile ($n = 35$), applying customised birthweight centiles[12].

	1st trimester		2nd trimester		3rd trimester	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)	1·02 (0·94–1·11)	0·6	1·00 (0·93–1·09)	0·9	0·99 (0·91–1·09)	0·9
No. cigarettes per day*	1·07 (1·00–1·14)	< 0·05	1·09 (1·01–1·17)	< 0·05	1·05 (0·97–1·15)	0·2
Educational level (high–low)	1·59 (0·88–2·89)	0·1	1·32 (0·73–2·89)	0·4	2·23 (1·14–4·37)	< 0·05
Paid work (yes/no)	1·41 (0·50–3·99)	0·5	1·04 (0·41–2·63)	0·9	0·86 (0·32–2·30)	0·8
No. hours housekeeping per week*	1·45 (0·93–2·27)	0·1	1·25 (0·81–1·93)	0·3	1·04 (0·65–1·67)	0·9
No. daily stressors*	1·04 (1·01–1·08)	< 0·05	0·99 (0·96–1·03)	0·7	1·03 (0·99–1·08)	0·1
Severity rating daily stressors* (low–high)	0·64 (0·26–1·56)	0·3	0·99 (0·44–2·25)	1·0	1·09 (0·42–2·86)	0·9
Social interactions*	0·98 (0·95–1·01)	0·1	1·00 (0·98–1·03)	0·7	0·99 (0·96–1·02)	0·5
Satisfaction with received support*	1·03 (0·98–1·08)	0·3	1·00 (0·95–1·05)	0·9	1·06 (0·99–1·13)	0·8
Depressive mood*	1·11 (1·00–1·23)	0·5	0·99 (0·89–1·11)	0·9	1·09 (0·98–1·22)	0·1
Anxiety*	0·82 (0·61–1·11)	0·5	1·04 (0·79–1·37)	0·8	0·92 (0·66–1·27)	0·6
Somatic complaints*	0·95 (0·82–1·10)	0·2	1·05 (0·91–1·21)	0·5	1·00 (0·85–1·17)	1·0

*In previous 2 months.

Table 5. Odds ratios (OR), 95% confidence intervals (CI) and *P* values of proposed risk factors to low birthweight for gestational age; low birthweight criterium set ≤ 10th centile ($n = 40$), applying conventional Dutch birthweight centiles[17].

	1st trimester		2nd trimester		3rd trimester	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)	1·02 (0·94–1·11)	0·7	0·97 (0·90–1·06)	0·5	1·00 (0·91–1·08)	0·9
Maternal height (cm)	0·94 (0·88–1·00)	0·06	0·94 (0·88–1·00)	< 0·05	0·94 (0·87–1·00)	0·07
Maternal weight (kg)	0·96 (0·91–1·00)	0·06	0·95 (0·91–1·00)	0·06	0·95 (0·90–1·00)	< 0·05
No. cigarettes per day*	1·08 (1·01–1·15)	< 0·05	1·11 (1·03–1·20)	< 0·01	1·07 (0·98–1·16)	0·1
Educational level (high–low)	1·56 (0·85–2·86)	0·1	1·64 (0·90–2·97)	0·1	1·79 (0·95–3·39)	0·07
Paid work (yes/no)	1·41 (0·50–3·97)	0·5	1·11 (0·43–2·87)	0·8	1·15 (0·44–3·02)	0·8
No. hours housekeeping per week*	1·59 (1·03–2·46)	< 0·05	1·09 (0·68–1·72)	0·7	1·03 (0·65–1·63)	0·9
No. daily stressors*	1·01 (0·98–1·05)	0·5	1·01 (0·98–1·04)	0·6	1·03 (0·99–1·06)	0·2
Severity rating daily stressors* (low–high)	0·41 (0·17–0·97)	< 0·05	0·60 (0·26–1·39)	0·2	0·94 (0·38–2·34)	0·9
Social interactions*	1·01 (0·98–1·04)	0·7	1·01 (0·98–1·03)	0·6	0·99 (0·96–1·02)	0·7
Satisfaction with received support*	1·00 (0·96–1·05)	0·1	0·99 (0·95–1·04)	0·8	1·02 (0·97–1·07)	0·5
Depressive mood*	1·12 (1·01–1·24)	< 0·05	0·99 (0·88–1·11)	0·8	1·09 (0·97–1·21)	0·1
Anxiety*	0·89 (0·66–1·19)	0·4	0·96 (0·72–1·28)	0·8	0·85 (0·61–1·18)	0·3
Somatic complaints*	0·91 (0·78–1·06)	0·2	0·99 (0·85–1·14)	0·9	1·00 (0·86–1·16)	0·1

*In previous 2 months.

tomised centile groups and the 10th Dutch birthweight centile group. Therefore, it can be concluded that the psychosocial risk factors especially affect the pregnancies with very low birthweight infants.

The current study is one of the largest prospective studies examining nulliparous women from as early as the first trimester of pregnancy. Earlier, smaller, prospective studies have also reported an association between maternal exposure to negative psychosocial circumstances and low birthweight for gestational age of the offspring[4,6,7,11,29,30]. The findings in most of the studies suggest that the effect of maternal stressors in predicting low birthweight should be considered seriously[10]. The effect of maternal stressors on low birthweight may be a direct or indirect effect by mediating through health risk behaviours such as cigarette smoking[10]. Low birthweight appears to be predicted most consistently by number of daily smoked cigarettes[1,2,4–6,31]. In the present study a paid job is not an independent risk factor for low birthweight for gestational age.

The definition of the outcome measure appears to be a critical point. We defined low birthweight in two ways: 1. by customised birthweight centiles which adjust for the confounders maternal height and weight, ethnic group, parity, neonatal gender, and gestational age[12,15,16] and 2. by the commonly used Dutch birthweight centiles which only correct for parity, neonatal gender, and gestational age[17]. As has been confirmed recently for the Dutch population[16], the customised birthweight centiles, based on almost 40,000 ultrasound dated, physiological pregnancies, are a much more precise representation of the characteristics of a population of newborns than the Dutch centiles, which only correct for parity, neonatal gender, and gestational age. It is known that the Dutch birthweight centiles are partly based on population data derived from nonultrasound dated pregnancies; these were mainly obtained in the first half of the twentieth century[16,17]. Nonultrasound dated pregnancy centiles underestimate birthweight in relation to gestational age. This may partly explain why, in the current study, the infants of 31 participants were reclassified as having a birthweight ≤ 10th centile, according to the customised birthweight centiles. The additional number of women included in the low birthweight for gestational age group in the customised centile method, compared with the Dutch centile method, cannot be explained by controlling for ethnic origin in the former method. Since the percentage of women of non-European origin in this study is very low (6·6%), and only six participants in the low birthweight for gestational age groups are non-European, ethnic origin cannot be the explanation for the differences. Apparently, controlling for maternal weight and height determines the shift into the low birthweight for gestational age categories.

It can be argued that 'customising' takes place when maternal height and weight is controlled for in the logistic regression analysis in which the low birthweight definition of the Dutch centile method was used. However, this was done after the participants had been allocated to either the low birthweight or the normal birthweight category. This may be an important reason why the results of the two methods differ from each other.

The specific method chosen to define low birthweight for gestational age affects the relation between maternal psychosocial factors and the weight of the infant at birth. Therefore we consciously used two methods to determine the outcome measure low birthweight. In this way we have demonstrated that psychosocial factors in the first trimester increase the risk of low birthweight, while the specific psychosocial risk factors found are different when the definition of low birthweight is changed. Therefore, in this field of research, we suggest use of the most valid definition for birthweight, being the customised birthweight centiles.

Although health care workers should be aware of the influence of psychosocial factors in the first trimester of pregnancy on low birthweight, future research has to broaden our understanding in this field, taking into account the pitfalls mentioned in the present study and in earlier work[10].

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